**Note Outline 22.1**

I. Astronomy is science that studies the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, dealing with the properties of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the \_\_\_\_\_\_\_\_\_\_\_ under which the universe operates.

II. Astronomy’s “Golden Age” (600 B. C. – 150 A.D.) began with the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The early Greeks were skilled at using \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to explain natural events. They developed the basics of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_, and used these tools to measure the sizes and distances of the \_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_.

A. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (384-322 B.C.) concluded the Earth was round after he observed the shadow cast by Earth on the moon.

B. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (276-194 B.C.) calculated the circumference of the Earth to within 1.7% of the actual circumference, using simple geometry and the sun’s position in the sky!

C. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ determined the location of over 800 stars, which he divided into six groups according to their brightness.

D. The early Greeks believed in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ universe. (*geo = Earth*) In this model, the moon, sun, and the known planets (Mercury, Venus, Mars, Jupiter, and Saturn) orbit (go around) Earth. Everything else was thought to be fixed in a crystalline sphere called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

E. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(312-230 B.C.) was the first Greek to propose a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (*helio = sun*) or sun-centered universe. In this model, Earth and the other planets orbit the sun.

F. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ presented his model of the universe, the Ptolemaic system, in 141 A.D. His model was able to accurately predict the motion of the planets, even the odd retrograde motion where planets seemed to move backwards in the sky. This system was also a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ model and remained unchallenged for nearly 13 centuries!

III. The birth of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ involved a separation from previous philosophical and religious views, and recognition of a universe governed by natural laws.

A. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(1473-1543) was convinced that Earth was not the center of the universe, but the sun was. He also conceived that the Earth \_\_\_\_\_\_\_\_\_\_\_\_\_\_ once per day, causing night and day. This was a major change from the notion that the Earth stood still and everything revolved around us! Copernicus’s published his explanation of the solar system in a text called *“De Revolutionibus, Orbium Coelestium”* (On the Revolution of the Heavenly Spheres). Copernicus and his followers were considered heretics by the Roman Catholic Church. Giordano Bruno, a Copernican devotee, was seized during the Inquisition in 1600 and, when he refused to denounce the Copernican theory, was burned alive at the stake.

B. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1546-1601) invented instruments he used for 20 years to measure the locations of heavenly bodies. His observations were extremely \_\_\_\_\_\_\_\_\_\_\_\_\_\_, and later used by Kepler to great extent. \*Tycho was also a bit fantastic… ☺

C. The brilliant understudy of Tycho was \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. He used Tycho’s extensive observations to develop 3 laws of planetary motion:

1. The path of each planet around the sun is an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, with the sun at one focus. The other focus is symmetrically located at the opposite end of the ellipse.

2. Each planet revolves so that an imaginary line connecting it to the sun sweeps over equal areas in equal time intervals. If a planet is to sweep equal areas in the same amount of time, it must travel more rapidly when it is \_\_\_\_\_\_\_\_\_\_\_\_\_ the sun and more slowly when it is \_\_\_\_\_\_\_\_\_\_\_\_\_ from the sun.

3. The \_\_\_\_\_\_\_\_\_\_\_\_\_ of the length of time it takes a planet to orbit the sun (orbital period) is proportional to the \_\_\_\_\_\_\_\_\_\_\_\_\_ of its mean distance to the sun. (T2 = d3).

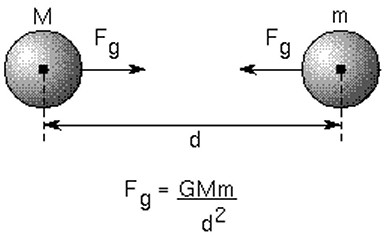
D. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(1564-1642) was a famous Italian scientist and the first scientist recorded to observe the heavens with a telescope. The simple telescope magnified distant objects to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ times the size seen by the unaided eye. His discoveries rocked the world, and published his findings in the *Dialogue of the Great World Systems*, which was condemned by the Church for promoting the Copernican view of the solar system. Major discoveries:

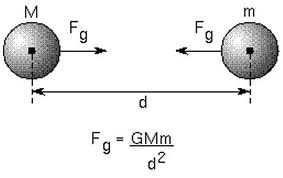
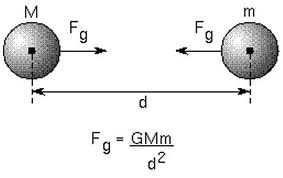
1. He discovered four of Jupiter’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, proving that Earth was not the only center of motion in the Universe.
2. He observed the planets through his telescope as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and not just points of light, showing that the planets were not stars as previously thought.
3. He discovered that \_\_\_\_\_\_\_\_\_\_\_ goes through phases just like the moon, proving that \_\_\_\_\_\_\_\_\_\_\_\_ orbits its source of light and not Earth.
4. He observed that the lunar surface was covered in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, showing that heavenly bodies were not smooth and perfect.
5. He observed sunspots, again showing that heavenly bodies are not perfect.

E. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(1642-1727) was the first scientist to formulate and test the law of universal gravitation.

IV. Universal Gravitation

A. Every body in the universe attracts every other body with a force that is directly proportional to their masses and inversely proportional to the square of the distance between their centers of mass.



B. Newton proved that the force of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, combined with the tendency of a planet to remain in straight-line motion, results in the elliptical orbits that Kepler discovered.[](http://www.google.com/imgres?imgurl=http://www.physicsoftheuniverse.com/images/relativity_gravity.jpg&imgrefurl=http://www.physicsoftheuniverse.com/dates.html&usg=__OIIKULeiUw2O4z5Yb0mEn0kSlRg=&h=243&w=386&sz=15&hl=en&start=0&zoom=1&tbnid=RRvDdm3yqnhA5M:&tbnh=98&tbnw=156&prev=/images%3Fq%3Dlaw%2Bof%2Buniversal%2Bgravitation%26um%3D1%26hl%3Den%26sa%3DX%26biw%3D1259%26bih%3D627%26tbs%3Disch:1&um=1&itbs=1&iact=hc&vpx=236&vpy=217&dur=3230&hovh=178&hovw=283&tx=145&ty=88&ei=gV58TNK1J8Oblge3oJDsCw&oei=gV58TNK1J8Oblge3oJDsCw&esq=1&page=1&ndsp=21&ved=1t:429,r:15,s:0)